Submitted to:
US EPA Region 8
Denver, CO

Submitted by:
Atlantic Richfield Company
La Palma, CA
May 10, 2013

# 2013 Solids Removal Work Plan

## Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

# Atlantic Richfield Company

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May 10, 2013

***VIA EMAIL AND OVERNIGHT COURIER***

Mr. Steven Way
On-Scene Coordinator
Emergency Response Program (8EPR-SA)
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

**Subject: 2013 Solids Removal Work Plan Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado**

Dear Mr. Way,

A digital file in PDF format of the 2013 Solids Removal Work Plan, Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01, Rico, Colorado dated May 10, 2013, is being submitted to you today via email. Three (3) hard copies of the report will also be sent by overnight courier to your office.

Atlantic Richfield Company (AR) is submitting this report responsive to requirements in Task B – Management of Precipitation Solids in the Upper Settling Ponds / Subtask B2 – Interim Ponds Solids Management of the Remedial Action Work Plan accompanying the Unilateral Administrative Order for Removal Action, Rico-Argentine Site, Dolores County, Colorado, U.S. EPA Region 8, Docket No. CERCLA-08-2011-0005.

If you have any questions or comments, please feel free to contact me at (714) 228-6770 or via email at Anthony.Brown@bp.com.

Sincerely,

Anthony R. Brown

Tony Brown
Project Manager
Atlantic Richfield Company

Enclosure (2013 Solids Removal Work Plan)

cc: Terry Moore, Atlantic Richfield
Sandy Riese, EnSci
Chris Sanchez, AECI
Dave McCarthy, Copper Environmental
Tom Kreutz, AECOM
Doug Yadon, AECOM
Mark Lombardi, AMEC
Spencer Archer, AMEC

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### Attachments

# 1.0 Introduction

AECOM Technical Services, Inc. (AECOM), in cooperation with Anderson Engineering Company, Inc. (AECI) and on behalf of Atlantic Richfield Company (AR), has prepared this 2013 Solids Removal Work Plan (Work Plan) to describe the actions that will be implemented at the Rico-Argentine Mine Site – Rico Tunnels Operable Unit (OU01) to remove solids via dredging from Ponds 11 and 12, and convey them to Pond 13 within the St. Louis Ponds system. Removal of solids from Pond 14 is proposed to be deferred until 2014. This work is responsive to Subtask B2 of Task B of the Removal Action Work Plan. A focused review of Ponds 11 and 12 removal alternatives to select the optimum removal method is presented herein. A more comprehensive evaluation of alternatives previously screened is presented in the Pond 15 Solids Removal Work Plan (AR, 2012).

Per discussions with the Environmental Protection Agency (EPA) (Steve Way, Wetland Demonstration Conceptual Design Teleconference, March 4, 2013), removal of solids from Pond 14 was proposed to be deferred until 2014. This deferral is necessary to accommodate time-critical construction, development and testing of demonstration-scale wetlands in, or near the Pond 18 area during 2013. Furthermore, solids from Pond 14 will likely have to be removed by conventional excavation due to debris within the pond, and disposal of such solids with dredged solids in Pond 13 is not feasible due to the difficulty in accessing Pond 13 with conventional earth-moving equipment while dredging of solids from Ponds 11 and 12 is conducted.

## 1.1 Scope

The 2013 solids removal of Ponds 11 and 12 involves: 1) implementation of a water management program within the upper St. Louis Ponds system to direct and control flows from the St. Louis Tunnel discharge during the removal operations; 2) extraction of solids by suction dredging from Ponds 11 and 12; and 3) conveyance of solids to Pond 13 for consolidation with previously dredged Pond 15 solids.

Solids have accumulated in the upper ponds of the St. Louis Ponds system as a result of precipitation and settling of metals by natural processes and by lime addition to the St. Louis Tunnel discharge from 1984 to 1995. Potential for release of water and flowable solids and the opportunity to increase overall detention led to the plan to remove solids from the upper ponds (see the Initial Solids Removal Plan [ISRP] dated May 2, 2011, submitted to the EPA by AR). The upper pond volumes are to be increased to provide adequate detention time and space for water and future accumulation of settled solids, and to reduce the potential impacts to the Dolores River in the unanticipated event of an uncontrolled release of the solids contents of one or more of the upper ponds to the river. All but 2 feet of Pond 18 solids was excavated conventionally by mechanical method and placed in an interim drying facility constructed over the inactive Ponds 16/17 area in 2011. The two feet were left in place to retard the downward seepage of pond water through any calcine tailings present and into the underlying predominantly coarse-grained alluvium deposits. Pond 15 solids were dredged and conveyed to interim storage in Pond 13 in 2012, again leaving approximately 2 feet in place (for the same reason). The scope of the 2013 removal project involves dredging Ponds 11 and 12 solids and conveying these removed solids to storage in Pond 13 together with the previously placed Pond 15 solids.

Pond 15 will continue to serve as the initial settling cell for the St. Louis Tunnel discharge water until dike improvements discussed in Section 4.2.3 are completed. It is anticipated that these improvements will be completed by the start of solids removal, and Pond 18 will be brought back online with discharge outlet to Pond 15. Although the Wetland's Demonstration is in the conceptual design stage, it is anticipated that a small portion (up to 50 gpm) of the St. Louis Tunnel discharge water will be routed to the Wetlands Demonstration and outlet to Pond 18 where it will be recombined with the remainder of St. Louis Tunnel discharge. Tunnel flow from Pond 15 will be routed around Ponds 11, 12, and 14 as needed to facilitate the solids removal activities as discussed later in Section 4.1.

As discussed in Section 4.3, following the removal of solids from Ponds 11 and 12, the total solids volume transferred into Pond 13 is expected to reach approximately 4,000 to 5,000 cubic yards (cy) (including solids from Ponds 11, 12 and 15). Improvements to Pond 13 completed in 2012 resulted in a total of approximately 10,000 cy of dredged solids storage capacity. Following placement of approximately 2,200 cy of solids from Pond 15 in 2012, adequate capacity of approximately 8,000 cy remains to accommodate solids to be removed from Ponds 11 and 12 in 2013. The design and operation of Pond 13 is described in the 2012 Pond 15 Solids Removal Work Plan approved by the EPA (August 3, 2012). Figures showing the location of anticipated solids removal from Ponds 11 and 12 and disposal in Pond 13 are presented in Attachment 1.

## 1.2 Responsibilities

The Ponds 11 and 12 solids removal and interim storage in Pond 13 will be completed under the direction of AR per approval of the EPA. AECOM will be the responsible Engineer, with AECI providing technical support and planning for the dredging and water management operations, as well as field oversight, management, construction quality control, and surveying. Dredge operation, pond dike construction, and other construction activities will be provided by a qualified construction contractor to be determined, under direction and oversight by AECI. These roles are summarized as follows:

- **Responsible Party** – AR
- **Design** – AECOM (Engineer)
- **Field Oversight/Construction Management/QC** – AECI (Field Manager)
- **Survey** – AECI
- **Construction Contractor** – TBD
- **Dredge Operation Assistance** – Pioneer Technical Services, Inc.; AMEC Environment & Infrastructure, Inc. (AMEC)

# 2.0 Objectives

The main objective of this work is to remove solids from Ponds 11 and 12 and consolidate them to an interim storage facility in Pond 13 as part of the management of precipitated solids responsive to Subtask B2 of Task B of the Removal Action Work Plan and the approved ISRP. The components of this objective of the Pond 11 and 12 solids removal described in this Work Plan are:

- Improve access to Ponds 11 and 12 as necessary to facilitate the removal of solids via suction dredging.
- Implement a water management plan for the St. Louis Ponds system and the dredging operation during Ponds 11 and 12 dredging operations.
- Remove Ponds 11 and 12 solids via suction dredge and transfer these solids via slurry line to Pond 13, leaving a nominal 2 feet of solids and the underlying existing calcines (if any) in Ponds 11 and 12. The remaining solids are to limit seepage loss to the underlying calcines and predominantly coarse-grained alluvial aquifer. Debris consisting of logs and cables has been observed in Pond 11, and depending on the ability to remove that debris prior to dredging, might limit the extent to which solids can be removed via dredge.

The design bases and work tasks necessary to achieve these objectives are described in the following sections of this Work Plan.

# 3.0 Summary of Removal Alternatives

Several solids removal methods were thoroughly examined in 2012 for solids removed from Pond 15. These options included removal by suction dredge, conventional excavator, drag line, and slusher hoist. The method ultimately selected was removal via suction dredge. Given the success of the dredge removal in Pond 15 and the analogous access conditions and constraints in Ponds 11 and 12 discussed below, removal by suction dredge is also preferred for Ponds 11 and 12.

The operation of the suction dredge is by remote control with emergency cut-off capability from shore. The suction dredge operation consists of an unmanned (remote control), floating, shallow-draft barge with a rotating horizontal cutter-head to dislodge solids to feed to a slurry pump system and discharge line. This type of equipment facilitates removal of wet solids with the physical properties of viscous sludge. Barge-mounted suction dredges are capable of sludge or sediment removal in water-occupied locations, and the source areas do not require draining or drying. Suction dredge technology has been successful in removing large quantities of water-submerged materials and transporting and accommodating several methods of disposal. Use of suction dredges with cutter-heads has proved a viable method of removal of solids at settling ponds at Atlantic Richfield's Butte Treatment Lagoons (BTL) sediment removal activities in Butte, Montana as well as recently for Pond 15 at the Rico Site. The Butte solids removed are generally consistent with the physical properties of the materials located at Rico and of similar depths and quantities.

The suction dredge method does not require the extensive geotechnical improvements to existing dikes to access the pond that are otherwise required by large excavation equipment. No pumping of pond fluids is needed, nor is a drying period for the solids prior to removal. No access causeways are required to reinforce the foundation pad for excavation equipment to enter the pond area for adequate reach to remove solids. The barge-mounted dredge is not hindered by groundwater conditions, as the equipment is floated on water currently in the pond. Water safety procedures will have to be fully implemented when working with barge-mounted suction dredge equipment.

Due to the significant amount of debris in Pond 14, suction removal by dredging is not feasible; and for reasons previously discussed in Section 1.0, removal will be deferred until 2014, with previous concurrence of the EPA.

# 4.0 Ponds 11 and 12 Solids Removal Work

The Ponds 11 and 12 solids removal will involve three areas of work:

- **Water Management** of the existing St. Louis Tunnel discharge will be separated into a circuit separate from the Ponds 11 and 12 dredging / Pond 13 settling circuit to minimize the potential for release of pumped solids. St. Louis Tunnel discharge water will be managed to maintain detention time for settling existing tunnel effluent, as well as provide recirculation and detention for water used in the dredging operation.
- **Pond Access and Dike Improvements** consisting of minor grading, leveling, filling, and surfacing in the Ponds 11 and 12 area will provide for adequate equipment access.
- **Suction Dredge Solids Removal** will involve an unmanned suction dredge sludge removal system that will be used to collect and pump the solids from Ponds 11 and 12 and transfer them to the Pond 13 facility, with recirculation of decanted water back to Pond 14.

## 4.1 St. Louis Ponds System Water Management

The St. Louis Ponds system water management plan will control flows from the St. Louis Tunnel discharge to regulate flows through and maintain adequate detention time within the existing ponds network during Ponds 11 and 12 solids removal activities. As part of the plan, the system will be separated into two circuits: a circuit to continue managing St. Louis Tunnel discharge, and a circuit to manage the dredging/settling. Key elements of the water management plan are shown on figures included in the appendix to the Technical Memo in Attachment 2. The water management plan will consist of the following elements:

- **Upper Ponds Water Management (Ponds 15 and 18)** – St. Louis Tunnel discharge water will normally be directed to Pond 18 and/or 15 during the removal operations. The removal of solids in 2011 and 2012 from Ponds 18 and 15 respectively, expanded the capacities of the ponds. Pond 18 requires repair of an old outlet for flow control before it will be brought online. Bringing Ponds 15 and 18 back online will aid in maintaining detention time for the tunnel discharge water during the dredging operation.
- **Dredging Circuit Inflow Isolation – Ponds 11, 12, and 14 Bypass** – Because the discharge from the upper ponds may at times exceed the need for water in the dredging circuit, a 12-inch gravity feed PVC or HDPE pipeline will be installed from Pond 15 to Pond 9. This pipeline will be used to route water around Ponds 11, 12, and 14 to isolate them from the ponds settling circuit during dredging operations. Pond 15 is the best place to intercept the upstream circuit and will allow the circuit to be used in the future for Pond 14 Solids Removal. As an alternative, a tap to this line will be provided to serve the Pond 9 Pilot-Scale Wetlands as appropriate to minimize the change of introducing water from the dredging circuit to the wetlands. The gravity feed pipeline will have capacity for a flow of approximately 1,300 gpm, which addresses the estimated seasonal peak St. Louis Tunnel discharge quantity and the flow resulting from a 25-year/24-hour storm within the ponds area. Any flow in excess of a 25-year/24-hour storm will be passed through the pond spillways. A separate pipeline will be fitted with a supplemental back-up pump and used as needed; however, the back-up pump will

remain offline unless required to relieve stormwater or added tunnel discharge. The pump capacity will be up to 1,500 gpm to accommodate discharge flow and direct rainfall into the ponds.

- **Dredging Circuit Outflow Isolation – Ponds 11, 12, and 14 –** Ponds 11 and 12 will be kept lowered as practical to minimize the chance of solids disturbed by the dredge from escaping the dredging circuit through the Pond 11 outlet to the lower ponds. Pond 14 will receive the recirculation water and overflow from an existing uncontrolled spillway to Pond 12. A balance between water level necessary for dredging and water level needed to minimize flow will be managed during operations. The existing Pond 11 outlet is uncontrolled and will be controlled by sandbag or earthen cofferdams and/or by silt fence to minimize solids outflow as feasible and necessary. The Pond 11 outlet is an old structure, and a 20-foot buffer zone will be created around it where dredging will not be conducted to avoid disturbing it and prevent uncontrolled release if the decant structure shifts. For this same reason, lowering of the pond level will be restricted to avoid consolidating the solids around the structure.
- **Dredging Circuit Outflow Isolation – Pond 13 Recirculation –** Recirculation of decanted water from Pond 13 back to Pond 14 (which discharges via an uncontrolled spillway into Pond 12) will be used to maintain dredging operations as well as prevent overflow of Pond 13 decant water to the lower ponds. Pond 13 Normal High Water Elevation (NHWL) level of 8810.0 will be maintained via the recirculation pump system. This elevation provides 2.0 feet of freeboard on the Pond 13 dikes and 1.0 feet of freeboard to an emergency overflow established at elevation 8811.0 between Pond 13 and Pond 10. The capacity of Pond 13 between NHWL and emergency overflow is sufficient to capture in excess of the 25-year/24-hour stormwater event within Pond 13.
- **Dredging Circuit Supplemental Supply Water –** To provide additional make-up water for dredging and pumping operations and to float the dredge barge, Pond 15 can be directed to Pond 14 as needed from the upper ponds or the dredging recirculation line from Pond 13.
- **Stormwater Diversion –** The existing stormwater diversion will be maintained for use during solids removal activities. The diversion channel was design to route run-on from a 25-year/24-hour return period storm event for the interim drying cell area and Pond 18 removal in 2011. This diversion channel was expanded during the 2012 solids removal and will serve to control run-on into Ponds 11, 12, 13, 14, 15, and 18 during these work activities.

As Pond 13 begins to fill with settling slurry, the decanted water will be pumped back into Pond 14 to recirculate the water utilized by dredging and keep disturbed solids in the closed circuit. When recirculation begins and no additional flow is needed into Pond 14, the St. Louis Tunnel discharge water will be directed into Pond 15 and/or 18, and the water from Pond 15 will be diverted to Pond 9 to bypass flow into Pond 11 and 12. In the event that Pond 13 receives a significant storm event, the emergency overflow of Pond 13 will flow by gravity flow into Pond 10. Pond 10 will be used in this scenario to supplement storage of water and as a potential interim water handling / supplemental detention pond.

Calculations in Attachment 2 estimate that more than 80 percent of the solids in the slurry are expected to settle out in Pond 13 at maximum production rate. The calculations are based on the grain size of Pond 15 solids. Ponds 11 and 12 solids are expected to be finer, and thus solids removal efficiencies may be lower. Actual settling will be monitored closely and will depend on actual production rates as well as the characteristics of the solids themselves.

Removal of Pond 15 solids in 2012 via dredging resulted in nearly 100 percent removal, as actual production rates resulted in very little recirculation required. Should solids be much finer than anticipated, the schedule can accommodate slower production rates to settle solids, or a flocculent selected for Pond 15 removal last year can be added. Since the dredge/recirculation circuit is essentially closed, it is not expected that the suspended solids will escape the circuit as long as design storms are not exceeded.

## 4.2 Pond Access and Dike Improvements

### 4.2.1 Pond 11 and 12 Access

Access pads are required to allow an excavator or crane to lower and lift the dredge and barge into and from Ponds 11 and 12. The pads will be constructed on the west side of the ponds near the ponds' intersection, as shown on the figures in Attachment 1. Pad construction will consist of minor grading, leveling, compacting, and gravel surfacing as necessary. Slope stability has been checked for a launch configuration utilizing a Caterpillar 330 class excavator staged at the edge of the constructed pads to pick and set the FLUMP dredge into the ponds. The configuration, geotechnical parameters, and results of the stability analyses are provided in Attachment 2. The factors of safety (FS) in all cases analyzed (without the use of timber mats or other load distribution) exceed 1.6 and are adequate for safe launch. The combined load of the medium-duty truck (GVWR 15,000 pounds or less) planned to haul the FLUMP dredge and trailer is substantially less than the excavator and will pose no stability concerns during launch and removal.

### 4.2.2 Dike Access

Work areas are to be accessed by site existing roads and along embankment (including dike) roads as shown on the figures. Geotechnical stability analyses of the same dike, utilizing loading equivalent to a Caterpillar 330 class excavator (the equipment suggested to implement embankment work), were completed for the Interim Flood Dike Upgrades project completed June 2012. Weight distribution timber mats will be required for excavation equipment on the dike. The figures in Attachment 1 define site access routes that will receive grading, leveling, compacting and gravel surfacing as necessary to facilitate access. All access roads, including roads along the dikes, will be maintained and repaired as needed as part of the dike work. Prior to starting work, a utility locate is to be completed on the site by use of Colorado "One Call/Blue Stake" and a second private locator for on-site private utilities.

### 4.2.3 Dike Maintenance

The St Louis Pond dikes related to pond access and pond system water management will be maintained and improved as needed to facilitate the work. Pond 18 requires repair of an old outlet for flow control. The damaged pipe end will be removed and sealed or replaced to control pond flows. The dike in the area of the pipe will be backfilled, compacted and shaped under the direction of a registered geotechnical engineer. Dike erosion control features shall also be monitored and maintained. Access roads along the dike top areas will be graveled as needed and erosion control rip-rap placed in areas that may require supplemental erosion protection

## 4.3 Suction Dredge Solids Removal

### 4.3.1 Removal Quantity

A nominal undisturbed 2-foot continuous layer of solids will be left in place to retard the downward seepage of pond water through any calcine tailings present and into the underlying predominantly coarse-grained alluvium deposits. It is estimated that approximately 3,000 cy of solids in Ponds 11 and 12 will be left in place, thereby requiring approximately 1,500 cy from Pond 11 and 2,200 cy from Pond 12 for a combined 3,700 cy of solids (measured on an in-pond consolidated basis) to be slurried and pumped from these two ponds into Pond 13. Existing and incoming solids in Pond 13 are expected to further consolidate upon being allowed to drain, resulting in a net reduction in solids volume due to consolidation. Previous experience has demonstrated that undisturbed and previously undrained similar solids can experience primary consolidation of up to 50 percent reduction in volume; however, actual consolidation is expected to be substantially less in this instance due to shallow groundwater underlying Pond 13 impeding free drainage from the solids.

### 4.3.2 Operation of the Dredge

An unmanned (remote controlled) barge-mounted suction dredge with an agitation cutting head is planned for the solids removal. The dredge system is manufactured by SRS Crisafulli. A traverse system to maneuver and guide the dredge will be constructed spanning Ponds 11 and 12 in the east-west direction to allow anchoring of the system on the accessible north-south dikes on either side of the ponds. The traverse system will consist of cables complying with manufacturer's requirements for anchoring and weights of the equipment. The traverse system will enable the dredge to move in an east-west direction (shortest length) across the pond and will need to be relocated after a portion of the pond is dredged. The J-Series Severe Duty FLUMP, which weighs approximately 4,500 pounds, will be off-loaded by a crane or loader/excavator rated for a minimum of 6,000 pounds. Per manufacturer's recommendations, four lifting slings of equal length, at least 15 feet in length, will be attached to the four FLUMP lifting eyes (provided) with a clevis at each eye. Each of the four lifting slings is attached to the lifting ring of the crane or the hoist. The FLUMP will be raised and positioned over a suitable launch site with at least 18 inches of freestanding water to float the dredge barge. The FLUMP will then be lowered into the water and temporarily secured with at least two anchor stakes using the accessible pads to be built on the west sides of Ponds 11 and 12.

Once in the pond, the dredge will be operated remotely from the shore using a control panel, a remote and traverse system. The FLUMP dredge consists of a 50-horsepower electric motor to drive the pump and cutter-head. The motor is powered by a 125 kV generator located on the pond bank. Approximately 300 feet of floating discharge line will feed the slurry to the on-shore slurry pipeline. The FLUMP's 7.5-foot horizontal rotating cutter-head will be lowered 6 to 12 inches into the solids while the dredge advances at approximately 3 feet/minute. The dredge will traverse the same path along the cable system in a lane fashion, using several passes to remove the solids, leaving 2 feet of undisturbed solids lining the pond behind. The dredge operator must pay special attention to the pond water level, pond contour map, and visual indicators to ensure that 2 feet of solids are left undisturbed to line the pond. The dredge will then be moved sideways approximately 8 feet to the next lane, and the operation is repeated over the entire area of the pond. The cutter-head only operates during forward movement. The pumping rate should be maintained to prevent solids from clogging the discharge hose at a minimum of approximately 500 gpm.

The resulting slurry from the dredge will be pumped through the slurry pipeline into the southwest corner of Pond 13. Once Pond 13 begins to fill, the colloidal water will be recirculated back to Pond 14. The floating recirculation intake will be located in the southeast corner of Pond 13. During the dredging operations, the water/slurry level in Pond 13 will be continuously monitored, and pumping will be initiated before the level reaches 8810.0. If necessary to prevent solids from forming too high of a beach at the distribution point, the discharge point may be shifted to the northwest as dredging progresses.

At the end of each day, water will be pumped through the slurry pipeline to ensure that the slurry does not settle or create any blockages within the slurry pipeline.

### 4.3.3 Water Safety

The dredge work will be completed in compliance with the BP Guidance on Practice for Design and Construction Activities Adjacent to or in Water Bodies in Conduct of Remediation of Onshore Decommissioning Activities and applicable Marine Safety requirements. A Marine Assurance Plan prepared for the 2012 Pond 15 solids removal work has been updated that includes the water work scope, location, and conditions, marine experts, vessels, inspection, operators, and vessel safety. A Water Work and Vessel Emergency Response and Contingency Plan will also be incorporated with the Marine Assurance Plan. All employees working with the dredge operation will be trained and competent regarding the use of the equipment and the water safety plans.

### 4.3.4 Floating Pipe and Other Pipe Works

Up to 300 lineal feet (depending on where the floating pipe connects to the on-shore pipeline) of 6 inch floating pipe and power-insulated conductor cable will be required for the FLUMP to operate over the entire area of Ponds 11 and 12. Approximately 250 feet (depending on where the floating pipe connects to the on-shore pipeline) of onshore 6-inch HDPE, PVC, or Aluminum pipe will continue the discharge line to the southwest corner of Pond 13.

### 4.3.5 Recirculation System

A centrifugal pump will recirculate decant water back from Pond 13 back into Pond 14 at approximately the same rate as the slurry is being placed into Pond 13 (500 to 700 gpm) once a stable pond elevation is reached. Approximately 480 feet of 6 inch HDPE recirculation pipe will be routed from the southeast corner of Pond 13 to the southeast corner of Pond 14 along a step located just below the upstream edge of the dike crest.

### 4.3.6 St. Louis Input Flow to Bypass Pond 11, 12, and 14

A 12-inch gravity feed HDPE pipeline will be installed from the outlet of Pond 15 to the inlet of Pond 9 to bypass the dredging operation being conducted in Ponds 11 and 12 and return water storage in Pond 14. This pipeline will be used to route water around Ponds 11, 12, and 14 to isolate them from the ponds settling circuit during dredging operations. A tap into this pipeline can be provided to serve the Pond 9 Pilot-Scale Wetlands as appropriate to minimize the change of introducing water from the dredging circuit to the wetlands. The gravity feed pipeline will flow approximately 1,300 gpm at capacity, which addresses the estimated seasonal peak St. Louis discharge quantity and the flow resulting from a 25-year/24-hour storm within the ponds area. Any flow in excess of a 25-year/24-hour storm will be passed through the pond spillways. A separate pipeline (HDPE or PVC) will be fitted with a supplemental back-up pump and used as needed; however, the back-up pump will remain offline unless required to relieve storm water or added tunnel discharge. The pump capacity will be up to 1,500 gpm to accommodate discharge flow and direct rainfall into the ponds. The diversion plan in Attachment 1 defines the bypass pipeline network.

### 4.3.7 Equipment

The dredging operations will require specific equipment to access the site safely and effectively complete the work. SRS Crisafulli (dredge manufacturer) recommends the 4-inch severe duty FLUMP suction dredge with cutter-head for removal of the solids contained in Ponds 11 and 12. The equipment will be obtained on a rental basis from SRS Crisafulli and will include:

- 4-inch FLUMP severe duty suction dredge system
- ~300 LF of 6-inch floating discharge line
- Cable traverse system for controlling FLUMP
- SRS Crisafulli representative on-site for FLUMP mobilization, equipment set-up, and operator training for approximately two days
- 125 KVA generator to power FLUMP
- Trackhoe excavator or extending crane and four each 15-foot slings to place the FLUMP into and remove dredge from the pond
- Four to six concrete blocks to anchor cable traverse system
- Pump (750 gpm) to recirculate water to Pond 14
- ~480 LF of 6-inch pipe to recirculate colloidal water to Pond 14
- ~250 LF of 6-inch pipe for onshore slurry discharge line
- Pump (1,500 gpm) to transport water from Pond 15 to Pond 9
- ~720 LF of pipe to pump water from Pond 15 to Pond 9
- Approved boat and rescue skiff for service and water safety requirements

Support shall consist of the following:

- Inspect and ensure stability and safety (including signage) of access roads to the Ponds 11 and 12 removal sites and interim storage areas within Pond 13.
- Delineate the work areas and controlled area required for the project.
- Procure, deliver, and stage required equipment, tools, materials, and supplies as approved by AECI prior to mobilization. All equipment and materials shall be in good and safe working order and suited for the work to be completed (i.e., tracked excavator and/or extended boom reach excavator, dump trucks, skid-steer, loader, low ground pressure dozer and compactor). A staging area is to be established north of the St. Louis Ponds system in the existing fenced secured facility.
- Dredge inspection, initial assembly, rotation testing and training will be completed by a competent person provided by the manufacturer prior to launching the dredge. All electrical connections, inspection, and equipment testing will be performed in accordance with the established Lockout/Tagout procedures. Dredge installation and operation will be completed in accordance with manufacturer's instructions.

- Demobilization from the site will include all equipment, tools, supplies, and unused materials. All trash and debris will be removed for legal disposal and the work site left in a clean and orderly fashion.

# 5.0 Site Security and Safety

The St. Louis Ponds system work areas will be secured to control access by the public and unauthorized visitors. The work areas are currently fenced with 4-feet-high steel "T" fence posts with two strands of non-barbed wire marked with colored flagging along the eastern boundary. Access along the flood dike on the west area of the work area will be controlled by locked access gate. Warning signs are posted along the fence and at gates. The fence will be opened for equipment access to the work and the entries closed during off hours.

Safety concerns identified during preparation of this Work Plan include weather, uneven terrain, water hazards, and hazardous energy. Required personal protective equipment (PPE) will include work gloves, latex sampling gloves, hardhats, safety glasses, and steel-toed boots. The work will be conducted consistent with the Rico Site-Specific Health and Safety Plan. To minimize the potential for harm to personnel, equipment, or the environment, the work will be reviewed, and the appropriate Control of Work (CoW) items such as Project and Job Level Work Risk Assessments (WRAs), Daily Toolbox Meeting Records, Task Safety Environmental Assessments (TSEAs), and permits, if any, will be completed, signed, and countersigned by competent personnel, as appropriate, prior to initiating any tasks associated with this work.

Any operations to be performed within 6 feet of water greater than 3 feet in depth or that has a soft bottom of sufficient thickness to become an entrapment hazard that can pose a danger of drowning must comply with BP Guidance on Practice for Design and Construction Activities Adjacent to or In Water Bodies in Conduct of Remediation or On-shore Decommissioning Activities dated June 28, 2007. A Marine Assurance Plan and Emergency Response and Contingency Plan for Vessel and Water Safety will be prepared. Personal fall protection and flotation devices (e.g., Coast Guard approved Personal Floatation Device [PFDs] vests or Type IV PFDs such as approved ring life buoys, life rings, or throwing rings equipped with at least 90 feet of retrieval line) will be used. Operations requiring the use of an approved flat-bottom boat will also require a mandatory rescue skiff. A trained and competent skiff operator will remain in the immediate vicinity of the rescue skiff at all times while personnel are working on the water.

# 6.0 As-Constructed Drawings and Construction Documentation

Bathymetric (or probe) surveys will be performed pre- and post-removal to document the removal of solids from Ponds 11 and 12. In addition, the surface of solids deposited in Pond 13 will be LIDAR surveyed prior to and upon completion of removal and dewatering.

All quality control testing required in the specifications will be obtained and reviewed for compliance with technical requirements for each construction component. Ongoing field construction inspections will be documented by written report and photographic documentation at all phases of the construction and will be assembled in the final construction documentation file.

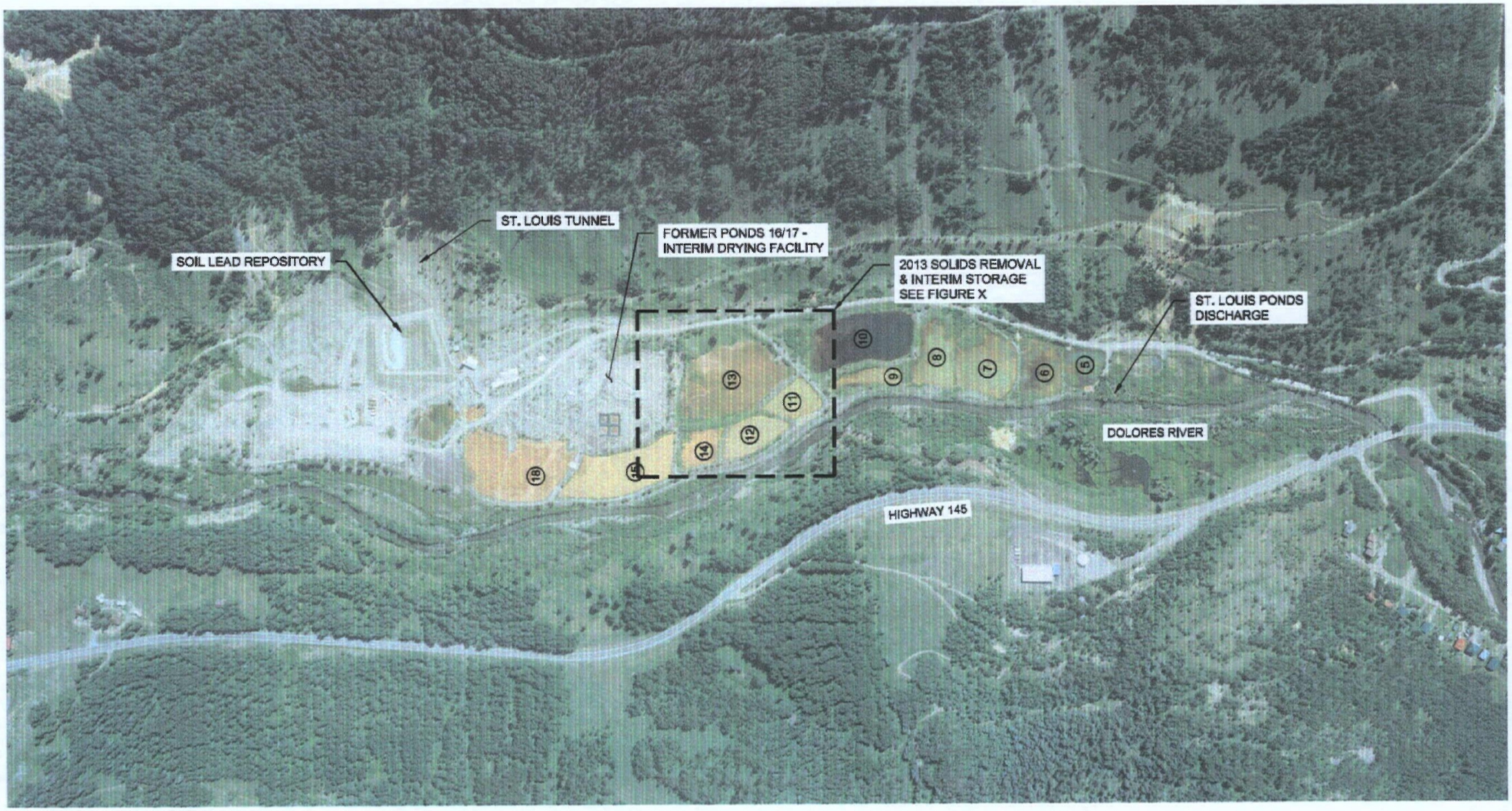
## 7.0 Schedule

The Ponds 11 and 12 Solids Removal will be completed on the schedule defined below. This schedule is subject to change based on actual field implementation time, weather and other ether unforeseen delays.

| | |
|---|---|
| • **Materials and Contractor Procurement:** | 5/13/2013 to 6/27/2013 |
| • **Mobilization:** | 6/26/2013 to 7/2/2013 |
| • **Work Site Preparation, Stormwater Controls:** | 7/8/2013 to 8/15/2013 |
| • **Dike Improvements:** | 7/8/2013 to 7/26/2013 |
| • **Water Management:** | 7/8/2013 to 9/13/2013 |
| • **Dredging:** | 7/22/2013 to 9/3/2013 |
| • **Demobilization:** | 9/4/2013 to 9/11/2013 |

# ATTACHMENT 1

## Figures




LOCATION MAP

Scale: 1"=400'

0 400' 800'

SCALE: 1" = 400'

# RICO-ARGENTINE SITE-OU01

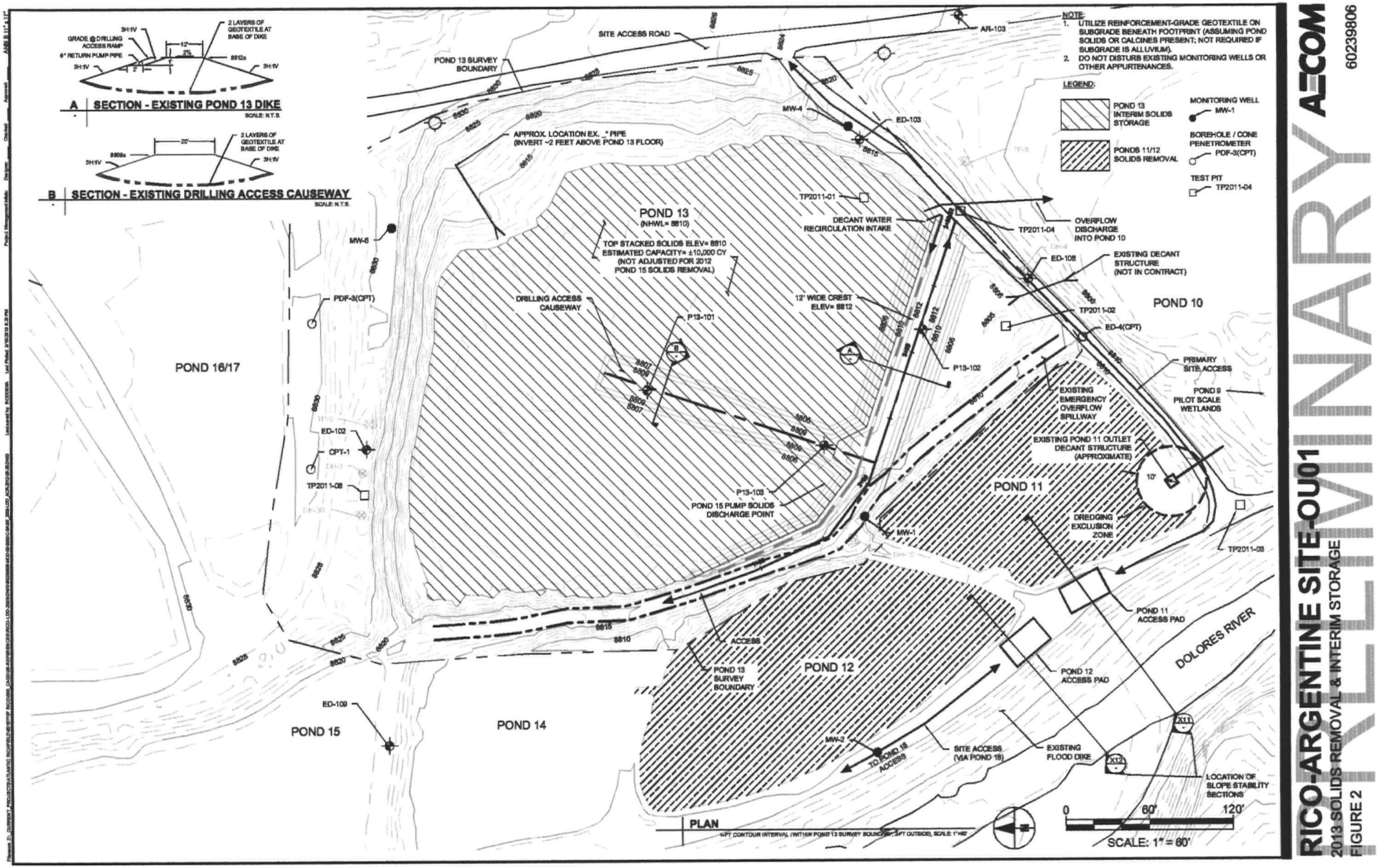
2013 SOLIDS REMOVAL & INTERIM STORAGE

FIGURE 1 - LOCATION MAP

PRELIMINARY

AECOM

60239806


A SECTION - EXISTING POND 13 DIKE
SCALE: N.T.S.
2 LAYERS OF GEOTEXTILE AT BASE OF DIKE
GRADE @ DRILLING ACCESS RAMP
6" RETURN PUMP PIPE
3H:1V
12'
2%
8812±
B SECTION - EXISTING DRILLING ACCESS CAUSEWAY
SCALE: N.T.S.
20'
8809±
SITE ACCESS ROAD
POND 13 SURVEY BOUNDARY
APPROX. LOCATION EX. _" PIPE (INVERT ~2 FEET ABOVE POND 13 FLOOR)
POND 13 (NHWL= 8810)
TOP STACKED SOLIDS ELEV= 8810
ESTIMATED CAPACITY= ±10,000 CY (NOT ADJUSTED FOR 2012 POND 15 SOLIDS REMOVAL)
DRILLING ACCESS CAUSEWAY
P13-101
P13-102
P13-103
12' WIDE CREST ELEV= 8812
POND 15 PUMP SOLIDS DISCHARGE POINT
DECANT WATER RECIRCULATION INTAKE
TP2011-01
TP2011-02
TP2011-03
TP2011-04
TP2011-06
MW-1
MW-2
MW-4
MW-6
ED-102
ED-103
ED-106
ED-109
ED-4(CPT)
CPT-1
PDF-3(CPT)
AR-103
OVERFLOW DISCHARGE INTO POND 10
EXISTING DECANT STRUCTURE (NOT IN CONTRACT)
POND 10
PRIMARY SITE ACCESS
POND 9 PILOT SCALE WETLANDS
EXISTING EMERGENCY OVERFLOW SPILLWAY
EXISTING POND 11 OUTLET DECANT STRUCTURE (APPROXIMATE)
10'
POND 11
DREDGING EXCLUSION ZONE
POND 11 ACCESS PAD
POND 12
POND 12 ACCESS PAD
POND 13 SURVEY BOUNDARY
ACCESS
DOLORES RIVER
SITE ACCESS (VIA POND 18)
EXISTING FLOOD DIKE
TO POND 18 ACCESS
LOCATION OF SLOPE STABILITY SECTIONS
POND 16/17
POND 15
POND 14
PLAN
1-FT CONTOUR INTERVAL (WITHIN POND 13 SURVEY BOUNDARY; 5-FT OUTSIDE), SCALE: 1"=60'
0
60'
120'
SCALE: 1" = 60'
NOTE:
1. UTILIZE REINFORCEMENT-GRADE GEOTEXTILE ON SUBGRADE BENEATH FOOTPRINT (ASSUMING POND SOLIDS OR CALCINES PRESENT; NOT REQUIRED IF SUBGRADE IS ALLUVIUM).
2. DO NOT DISTURB EXISTING MONITORING WELLS OR OTHER APPURTENANCES.
LEGEND:
POND 13 INTERIM SOLIDS STORAGE
PONDS 11/12 SOLIDS REMOVAL
MONITORING WELL MW-1
BOREHOLE / CONE PENETROMETER PDF-3(CPT)
TEST PIT TP2011-04
AECOM
60239806
PRELIMINARY
RICO-ARGENTINE SITE-OU01
2013 SOLIDS REMOVAL & INTERIM STORAGE
FIGURE 2

# ATTACHMENT 2

## Design Computations

# Technical Memo – Pond 15 to Pond 9 Diversion and Water Management

# TECHNICAL MEMO

## POND 15 to POND 9 DIVERSION AND WATER MANAGEMENT

RICO, DOLORES COUNTY, COLORADO

CLIENT:
**BP/AR**

PREPARED BY:

ANDERSON ENGINEERING
977 WEST 2100 SOUTH
SALT LAKE CITY, SALT LAKE COUNTY, UTAH
PHONE: 801-972-6222
WEBSITE: WWW.ANDERSONENG.COM

ANDERSON
ENGINEERING COMPANY INC.

MARCH, 2013

## 1.0 INTRODUCTION

The purpose of this report is to provide information relating to the proposed construction of a diversion pipeline bypassing Ponds 14, 12 and 11 of the St. Louis pond system. The location of pipe begins on the south side of Pond 15, continuing south on the east side of Ponds 14, 12 and 11 for approximately 700 feet with discharge laterals into Ponds 12 and 11 and an outfall into Pond 09. The following report includes a description of the existing and proposed drainage conditions, as well as supporting calculations and recommendations See C-1 in the Appendix.

## 2.0 PURPOSE AND SCOPE

Currently, Ponds 11 and 12 are being prepared to conduct removal from solids resulting from settlement of the St. Louis mine water discharge. The solids are to be by a dredging operation. Pond 14 will be used for recirculation of dredge water and will be scheduled for solids removal in 2014. Ponds 14, 12 and 11 are three of multiple ponds used for treating water runoff from the St. Louis mine shaft. While removing the sediment from Ponds 12 and 11, the mine discharge water will be diverted around the ponds allowing the removal to take place. Therefore, a diversion pipe will be placed from Pond 15 to Pond 09, to avoid drainage into Ponds 14, 12 and 11. In the event Pond 15 begins to over-fill during a excessive storm event, there will be a back-up pump and an additional pipeline leading from Pond 15 to Pond 09. Once the sediment removal is completed, the diversion pipeline and pumps will be removed and regular discharge between ponds resume.

## 3.0 RAINFALL DATA

Rainfall data was provided by Autodesk Storm and Sanitary Analysis 2013 (SSA) and verified by the NOAA Atlas 2 Volume III, Figure 29. The 25-year storm was modeled using a SCS Type II 24 Hr storm. Assigned rainfall depth for the 25-year storm for the St Louis Pond area near Rico, CO is as follows:

**25-Year/24 Hr Storm** = 2.90 Inches

## 4.0 CONTRIBUTING FACTORS

The first contributing factor to the total volume of pond water discharge is the outflow from the St. Louis mine adit. The runoff from the mine adit is being diverted into Pond 15 and through pond 15 with a seasonal historical peak flow of **2.90 CFS** as derived from 2008 to present.

During a 25 year SCS Type II 24 Hr storm, only the rain that falls within the area of the ponds is collected. A diversion structure has been constructed to route storm run-off around the subject ponds and will not contribute to the water budget for the pipeline bypass. The pond areas and increased volumes are calculated below.

**Pond 18 = 2.25 ac.**

**Increased Volume = 2.25 ac. x 2.9 inches = 23,685.75 CF**

**Pond 15 is 2.00 ac.**

**Increased Volume = 2.00 ac. x 2.9 inches = 21,054 CF**

The maximum increase of water volume from Pond 18 and a maximum increase of water volume from Pond 15 during a 24 Hr. period will not reach outlets at the same time. Therefore only the larger of the two volume increases will be considered.

## 5.0 STORM EVENT MODEL

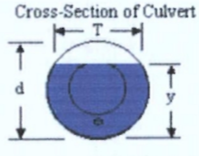
While maintaining a constant **2.90 CFS** from mine adit outflow, the additional volume from the 2.9 inch 25 year/24 hr storm will be contained by the ponds and passed through the system.

## 6.0 DIVERSION PIPE CALCULATIONS

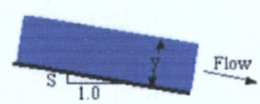
The peak flow of **2.90 CFS** from the tunnel outflow and the 2.9 inch 25-year/24 hr storm is detained within the excess storage volume of Pond 18 and Pond 15. The extra volume causes the water elevation in Pond 18 and 15 to rise, increasing the discharge outflow. A summary of storm water discharge through the diversion within the system is as follows:

**ASSUMPTIONS:**

Cross-Section of Culvert




Cut-away Side View




Pipe Flow, $Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$

Pipe Velocity, $V = \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$

Hydraulic Radius, $R = \frac{A}{P}$

Area of Water Flow, $A = \frac{1}{8}(\theta - \sin\theta) D^2 \ (ft^2)$

$\theta$ = Central Angle (radians)

D =Pipe Diameter (ft)

Wetted Perimeter, $P = \frac{1}{2}\ \theta D$
$\theta$ = Central Angle (radians)
D = Pipe Diameter (ft)

Pipe Slope, S = .02 (ft/ft)
Mannings Roughness, n = 0.011 for Plastic Pipe
D = 1.00 ft, 12 in.
y = 0.50 ft, 6 in.
$\theta = 180°$ for pipe half full

<u>CALCULATIONS (12" diameter, 6" full, 2.0 %):</u>

$A = \frac{1}{8}\ (\theta - \sin\theta)\ D^2 = \frac{1}{8}\ (\pi - \sin\pi)\ 0.50^2 = \underline{0.39\ ft^2}$

$P = \frac{1}{2}\ \theta D = P = \frac{1}{2}\ \pi\ 0.6667 = \underline{1.57\ \text{ft}}$

$R = \frac{A}{P} = \frac{0.17452}{1.04715} = \underline{0.25}$

$Q = \frac{1.49}{n}\ AR^{\frac{2}{3}}S^{\frac{1}{2}} = Q = \frac{1.49}{0.011}(0.39)(0.25^{\frac{2}{3}})(0.02^{\frac{1}{2}}) = \underline{2.985\ \text{CFS}}$

| WATER DEPTH IN 12" PIPE (FT) | FLOW (CFS) @ 2% |
|---|---|
| 0.5 | 2.9850 |
| 0.6 | 4.0114 |
| 0.7 | 4.9988 |
| 0.8 | 5.8362 |
| 0.9 | 6.3635 |
| 1.0 | 5.9707 |

As the water level rises with the increase in the intensity of the storm, the 12" pipe will accommodate the volume with an increased capacity up to 0.9 feet of water depth in the pipe. The added pond volume from storm water can conservitively be discharged through the 12" pipe in addition to the St Louis discharge. The St Louis water at 2.9 CFS and the increased storm water potentially contained in Pond 15 results in a maximum pipe discharge of about 6.0 CFS. The bypass 12 " pipe has a capacity at the slope proposed of 6.36 CFS. When the pipe is flowing full there is a slight drop in capacity but the maximum discharge is within the pipe capacity with minor backwater until drained.

## 7.0 SUMMARY

The water from Pond 15 is being diverted around Ponds 14 (recirculation pond), 12 and 11 through a 12" gravity flow diversion pipe into Pond 09 allowing the removal of mine sediment that has built up in Ponds 12 and 11. A secondary 6" supplimentry diversion pipeline is also available with a 3.34 CFS (1500 GPM) pump to accommodate any excess flooding of Pond 15 during a unforeseen storm event or to allow for gravity line maintainance. The storm water contained in Pond 18 and 15 from a 25-year/24 hr storm and the mine discharge flow of **2.90 CFS** from the St. Louis mine were calculated (Manning's open channel flow equation) to determine that the flow capacity of the 12" diversion pipe would be adequate to sustain the total amount of bypass water.

# APPENDIX

# RICO PONDS 15-9 DIVERSION AND WATER MANAGEMENT


## SHEET INDEX

SHEET C-1 - PLAN VIEW, PROFILES AND DETAILS

N

SCALE IN FEET
0 200 400

**01** **RICO PONDS**
SCALE - APPROX 1" = 200'



General Notes

| No. | Revision / Issue | Date |
|---|---|---|
| | | |

BP

ANDERSON

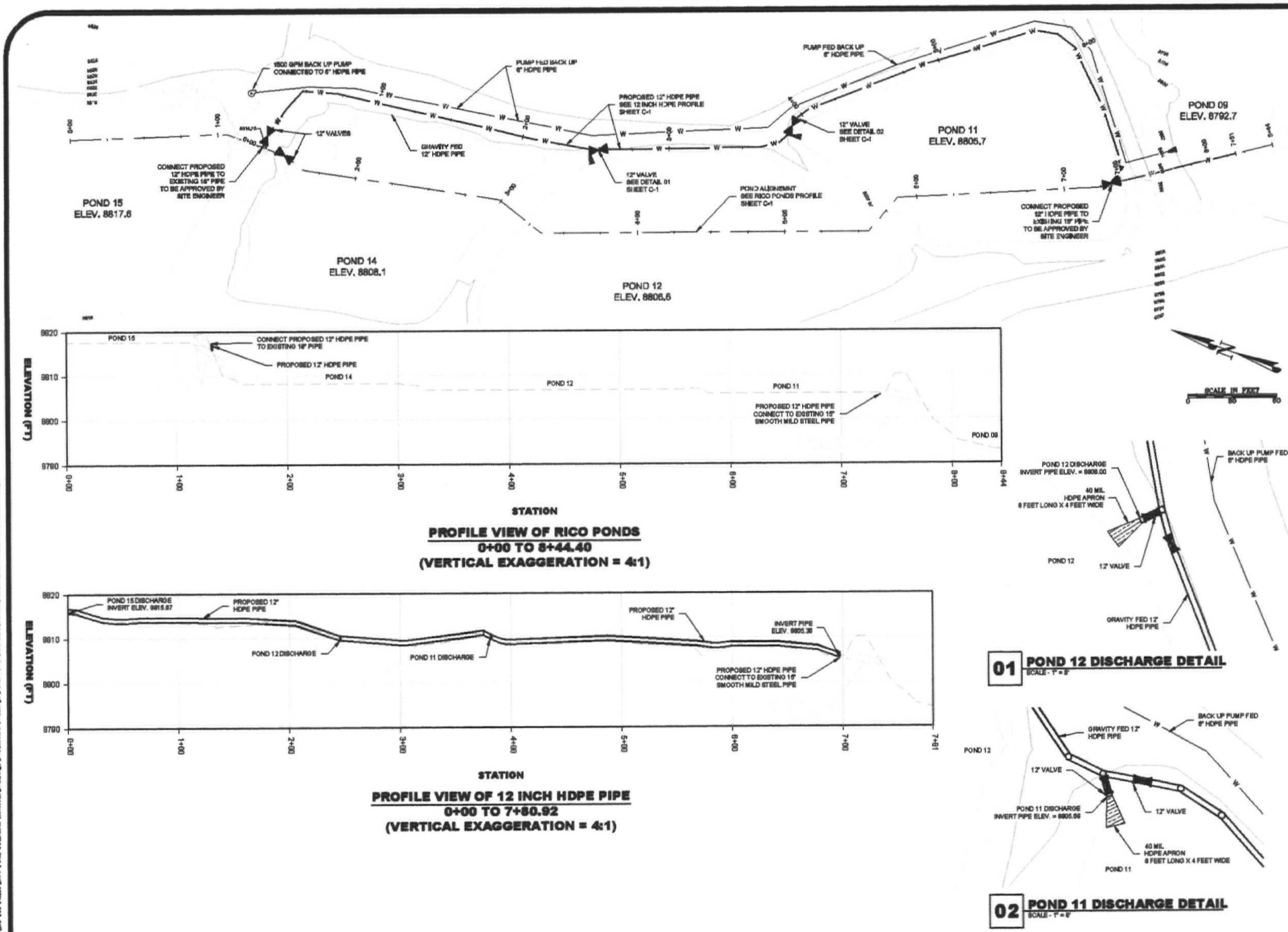
RICO PONDS 15-9
DIVERSION

COVER SHEET

RICO,
DOLORES COUNTY, CO

| | |
|---|---|
| DRAWN BY: | CAS |
| ENGINEER: | DBJ |
| APPROVED: | CS |

| | |
|---|---|
| Project | Sheet |
| Date 2013-03-13 | G-1 |
| Scale 1" = 200' | |




**PROFILE VIEW OF RICO PONDS**
**0+00 TO 8+44.40**
**(VERTICAL EXAGGERATION = 4:1)**

**PROFILE VIEW OF 12 INCH HDPE PIPE**
**0+00 TO 7+80.92**
**(VERTICAL EXAGGERATION = 4:1)**

**01 POND 12 DISCHARGE DETAIL**
SCALE - 1" = 5'

**02 POND 11 DISCHARGE DETAIL**
SCALE - 1" = 5'

**General Notes**

NOTES:
1. APPROPRIATE CONNECTION FITTINGS TO BE APPROVED BY FIELD ENGINEER

| No. | Revision/Issue | Date |
|---|---|---|

BP

ANDERSON

RICO PONDS 15-9
DIVERSION

PLAN VIEW, PROFILES AND DETAILS

RICO,
DOLORES COUNTY, CO

| | |
|---|---|
| DRAWN BY: | CAS |
| ENGINEER: | DBJ |
| APPROVED: | CS |

| | |
|---|---|
| Date | 2013-03-13 |
| Scale | AS SHOWN |
| Sheet | C-1 |

## Project Description

File Name ............................................................................ 130314 Pond 15-09 Diversion.SPF

## Project Options

| | |
|---|---|
| Flow Units | CFS |
| Elevation Type | Elevation |
| Hydrology Method | SCS TR-55 |
| Time of Concentration (TOC) Method | SCS TR-55 |
| Link Routing Method | Kinematic Wave |
| Enable Overflow Ponding at Nodes | YES |
| Skip Steady State Analysis Time Periods | NO |

## Analysis Options

| | | |
|---|---|---|
| Start Analysis On | Jul 26, 2012 | 00:00:00 |
| End Analysis On | Jul 28, 2012 | 00:00:00 |
| Start Reporting On | Jul 26, 2012 | 00:00:00 |
| Antecedent Dry Days | 0 | days |
| Runoff (Dry Weather) Time Step | 0 01:00:00 | days hh:mm:ss |
| Runoff (Wet Weather) Time Step | 0 00:05:00 | days hh:mm:ss |
| Reporting Time Step | 0 00:01:00 | days hh:mm:ss |
| Routing Time Step | 1 | seconds |

## Number of Elements

| | Qty |
|---|---|
| Rain Gages | 1 |
| Subbasins | 1 |
| Nodes | 11 |
| *Junctions* | 9 |
| *Outfalls* | 1 |
| *Flow Diversions* | 0 |
| *Inlets* | 0 |
| *Storage Nodes* | 1 |
| Links | 10 |
| *Channels* | 0 |
| *Pipes* | 10 |
| *Pumps* | 0 |
| *Orifices* | 0 |
| *Weirs* | 0 |
| *Outlets* | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

## Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RAIN_GAGE | Time Series | 25 YEAR USER DEFINED | Intensity | inches | None | None | 25 | 2.90 | SCS Type II 24-hr |

## Subbasin Summary

| SN | Subbasin ID | Area (ac) | Weighted Curve Number | Total Rainfall (in) | Total Runoff (in) | Total Runoff Volume (ac-in) | Peak Runoff (cfs) | Time of Concentration (days hh:mm:ss) |
|---|---|---|---|---|---|---|---|---|
| 1 | POND_18_15_DRAIN | 4.25 | 97.29 | 2.90 | 2.59 | 11.01 | 15.80 | 0 00:05:00 |

## Node Summary

| SN | Element ID | Element Type | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Initial Water Elevation (ft) | Surcharge Elevation (ft) | Ponded Area (ft²) | Peak Inflow (cfs) | Max HGL Elevation Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | STRC 01 | Junction | 8823.11 | 8824.19 | 8823.11 | 8824.19 | 0.00 | 1.97 | 8823.76 | 0.00 | 0.43 | 0 00:00 | 0.00 | 0.00 |
| 2 | STRC 02 | Junction | 8822.73 | 8823.80 | 8822.73 | 8823.80 | 0.00 | 1.97 | 8823.44 | 0.00 | 0.36 | 0 00:00 | 0.00 | 0.00 |
| 3 | STRC 03 | Junction | 8822.35 | 8823.43 | 8822.35 | 8823.43 | 0.00 | 1.97 | 8823.07 | 0.00 | 0.36 | 0 00:00 | 0.00 | 0.00 |
| 4 | STRC 04 | Junction | 8821.39 | 8822.47 | 8821.39 | 8822.47 | 0.00 | 1.97 | 8822.07 | 0.00 | 0.40 | 0 00:00 | 0.00 | 0.00 |
| 5 | STRC 05 | Junction | 8821.10 | 8822.17 | 8821.10 | 8822.17 | 0.00 | 1.97 | 8821.76 | 0.00 | 0.41 | 0 00:00 | 0.00 | 0.00 |
| 6 | STRC 06 | Junction | 8820.38 | 8821.46 | 8820.38 | 8821.46 | 0.00 | 1.97 | 8820.93 | 0.00 | 0.53 | 0 00:00 | 0.00 | 0.00 |
| 7 | STRC 07 | Junction | 8819.31 | 8820.38 | 8819.31 | 8820.38 | 0.00 | 1.97 | 8819.75 | 0.00 | 0.63 | 0 00:00 | 0.00 | 0.00 |
| 8 | STRC 08 | Junction | 8818.70 | 8819.77 | 8818.70 | 8819.77 | 0.00 | 1.97 | 8819.09 | 0.00 | 0.69 | 0 00:00 | 0.00 | 0.00 |
| 9 | STRC 09 | Junction | 8817.31 | 8818.99 | 8817.31 | 8818.99 | 0.00 | 1.97 | 8817.70 | 0.00 | 1.29 | 0 00:00 | 0.00 | 0.00 |
| 10 | OUTFALL | Outfall | 8812.03 | | | | | 1.97 | 8812.24 | | | | | |
| 11 | POND_18 | Storage Node | 8819.69 | 8826.00 | 8823.69 | | 0.00 | 17.58 | 8824.37 | | | | 0.00 | 0.00 |

## Link Summary

| SN | Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length (ft) | Inlet Invert Elevation (ft) | Outlet Invert Elevation (ft) | Average Slope (%) | Diameter or Height (in) | Manning's Roughness | Peak Flow (cfs) | Design Flow Capacity (cfs) | Peak Flow/ Design Flow Ratio | Peak Flow Velocity (ft/sec) | Peak Flow Depth (ft) | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged (min) | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PIPE 01 | Pipe | POND_18 | STRC 01 | 34.42 | 8823.19 | 8823.11 | 0.2200 | 12.000 | 0.0120 | 1.97 | 3.64 | 0.54 | 2.36 | 0.52 | 0.52 | 0.00 | Calculated |
| 2 | PIPE 02 | Pipe | STRC 01 | STRC 02 | 54.49 | 8823.11 | 8822.73 | 0.7100 | 12.000 | 0.0150 | 1.97 | 2.60 | 0.76 | 3.64 | 0.65 | 0.65 | 0.00 | Calculated |
| 3 | PIPE 03 | Pipe | STRC 02 | STRC 03 | 67.80 | 8822.73 | 8822.35 | 0.5500 | 12.000 | 0.0150 | 1.97 | 2.30 | 0.86 | 3.29 | 0.71 | 0.71 | 0.00 | Calculated |
| 4 | PIPE 04 | Pipe | STRC 03 | STRC 04 | 153.01 | 8822.35 | 8821.39 | 0.6300 | 12.000 | 0.0150 | 1.97 | 2.45 | 0.80 | 3.48 | 0.68 | 0.68 | 0.00 | Calculated |
| 5 | PIPE 05 | Pipe | STRC 04 | STRC 05 | 44.68 | 8821.39 | 8821.10 | 0.6600 | 12.000 | 0.0150 | 1.97 | 2.51 | 0.78 | 3.53 | 0.67 | 0.67 | 0.00 | Calculated |
| 6 | PIPE 06 | Pipe | STRC 05 | STRC 06 | 58.03 | 8821.10 | 8820.38 | 1.2300 | 12.000 | 0.0150 | 1.97 | 3.42 | 0.57 | 4.51 | 0.54 | 0.54 | 0.00 | Calculated |
| 7 | PIPE 07 | Pipe | STRC 06 | STRC 07 | 45.51 | 8820.38 | 8819.31 | 2.3700 | 12.000 | 0.0150 | 1.97 | 4.75 | 0.41 | 5.76 | 0.45 | 0.45 | 0.00 | Calculated |
| 8 | PIPE 08 | Pipe | STRC 07 | STRC 08 | 14.85 | 8819.31 | 8818.70 | 4.1000 | 12.000 | 0.0150 | 1.97 | 6.25 | 0.31 | 7.04 | 0.39 | 0.39 | 0.00 | Calculated |
| 9 | PIPE 09 | Pipe | STRC 08 | STRC 09 | 35.56 | 8818.70 | 8817.31 | 3.9000 | 12.000 | 0.0150 | 1.97 | 6.10 | 0.32 | 6.92 | 0.39 | 0.39 | 0.00 | Calculated |
| 10 | PIPE 10 | Pipe | STRC 09 | OUTFALL | 27.01 | 8817.31 | 8812.03 | 19.5500 | 15.000 | 0.0120 | 1.97 | 30.94 | 0.06 | 14.06 | 0.21 | 0.17 | 0.00 | Calculated |

# Subbasin Hydrology

## Subbasin : POND_18_15_DRAIN

### Input Data

Area (ac) .......................................................................... 4.25
Weighted Curve Number .............................................. 97.29
Rain Gage ID ................................................................ RAIN_GAGE

### Composite Curve Number

| Soil/Surface Description | Area (acres) | Soil Group | Curve Number |
|---|---|---|---|
| - | 3.75 | - | 100.00 |
| Fallow, bare soil | 0.50 | A | 77.00 |
| Composite Area & Weighted CN | 4.25 | | 97.29 |

### Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

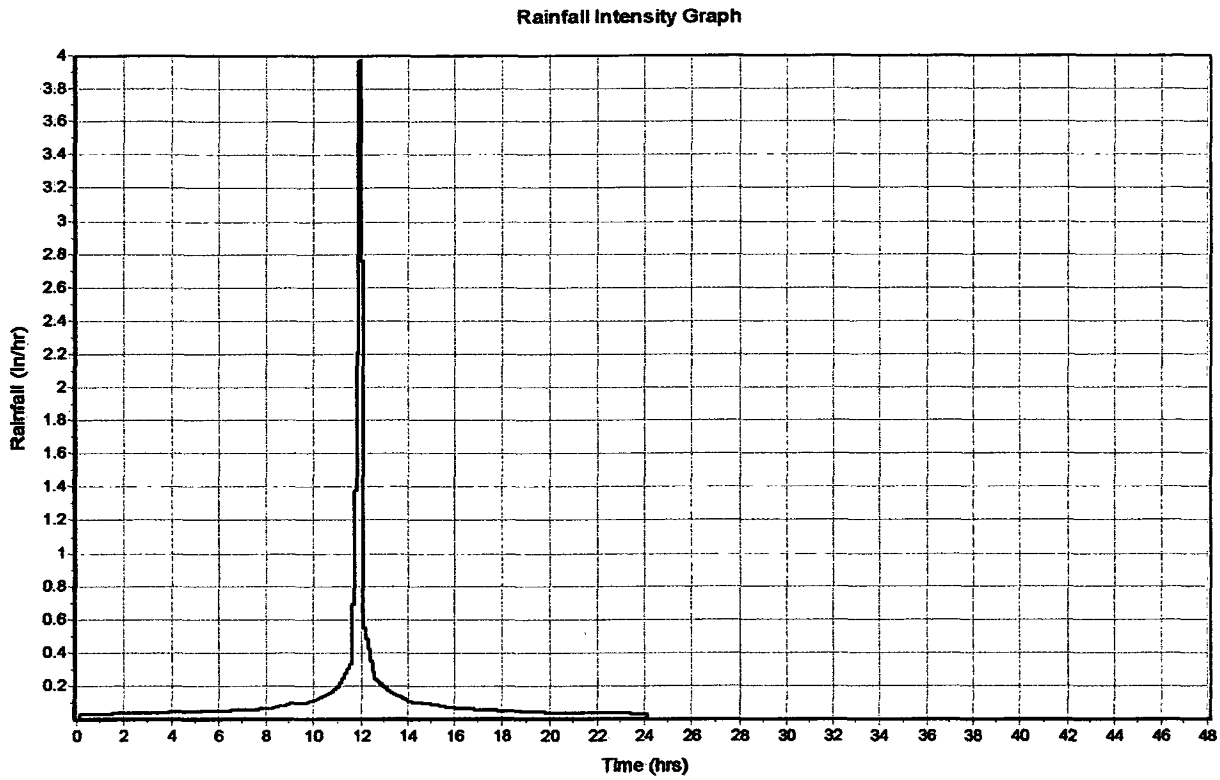
Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

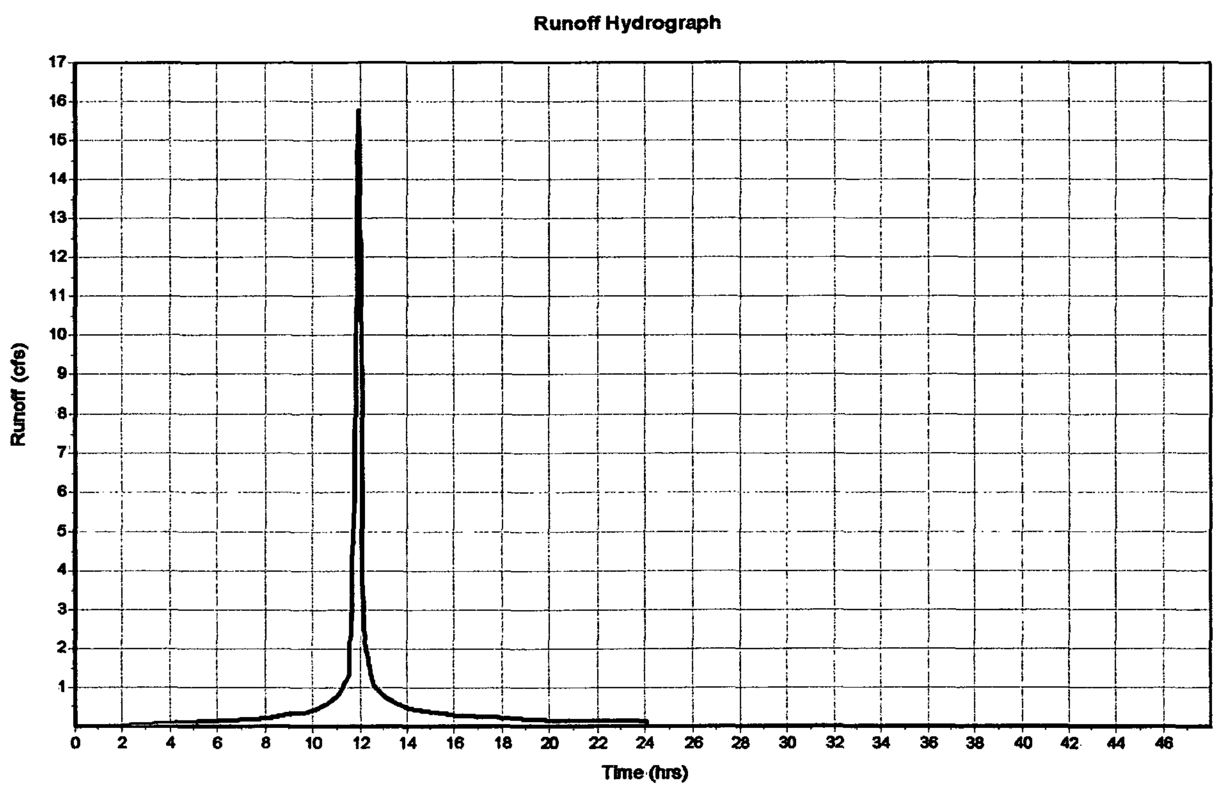
User-Defined TOC override (minutes): .1

### Subbasin Runoff Results

Total Rainfall (in) ............................................................ 2.90
Total Runoff (in) .............................................................. 2.59
Peak Runoff (cfs) ............................................................ 15.80
Weighted Curve Number ................................................ 97.29
Time of Concentration (days hh:mm:ss) ........................ 0 00:00:06

**Subbasin : POND_18_16_DRAIN**



## Junction Input

| SN | Element ID | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Ground/Rim (Max) Offset (ft) | Initial Water Elevation (ft) | Initial Water Depth (ft) | Surcharge Elevation (ft) | Surcharge Depth (ft) | Ponded Area (ft²) | Minimum Pipe Cover (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | STRC 01 | 8823.11 | 8824.19 | 1.08 | 8823.11 | 0.00 | 8824.19 | 0.00 | 0.00 | 0.00 |
| 2 | STRC 02 | 8822.73 | 8823.80 | 1.08 | 8822.73 | 0.00 | 8823.80 | 0.00 | 0.00 | 0.00 |
| 3 | STRC 03 | 8822.35 | 8823.43 | 1.08 | 8822.35 | 0.00 | 8823.43 | 0.00 | 0.00 | 0.00 |
| 4 | STRC 04 | 8821.39 | 8822.47 | 1.08 | 8821.39 | 0.00 | 8822.47 | 0.00 | 0.00 | 0.00 |
| 5 | STRC 05 | 8821.10 | 8822.17 | 1.08 | 8821.10 | 0.00 | 8822.17 | 0.00 | 0.00 | 0.00 |
| 6 | STRC 06 | 8820.38 | 8821.46 | 1.08 | 8820.38 | 0.00 | 8821.46 | 0.00 | 0.00 | 0.00 |
| 7 | STRC 07 | 8819.31 | 8820.38 | 1.08 | 8819.31 | 0.00 | 8820.38 | 0.00 | 0.00 | 0.00 |
| 8 | STRC 08 | 8818.70 | 8819.77 | 1.08 | 8818.70 | 0.00 | 8819.77 | 0.00 | 0.00 | 0.00 |
| 9 | STRC 09 | 8817.31 | 8818.99 | 1.68 | 8817.31 | 0.00 | 8818.99 | 0.00 | 0.00 | 0.00 |

## Junction Results

| SN | Element ID | Peak Inflow (cfs) | Peak Lateral Inflow (cfs) | Max HGL Elevation Attained (ft) | Max HGL Depth Attained (ft) | Max Surcharge Depth Attained (ft) | Min Freeboard Attained (ft) | Average HGL Elevation Attained (ft) | Average HGL Depth Attained (ft) | Time of Max HGL Occurrence (days hh:mm) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ac-in) | Total Time Flooded (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | STRC 01 | 1.97 | 0.00 | 8823.76 | 0.65 | 0.00 | 0.43 | 8823.71 | 0.60 | 0 11:55 | 0 00:00 | 0.00 | 0.00 |
| 2 | STRC 02 | 1.97 | 0.00 | 8823.44 | 0.71 | 0.00 | 0.36 | 8823.37 | 0.64 | 0 11:55 | 0 00:00 | 0.00 | 0.00 |
| 3 | STRC 03 | 1.97 | 0.00 | 8823.07 | 0.72 | 0.00 | 0.36 | 8823.00 | 0.65 | 0 11:55 | 0 00:00 | 0.00 | 0.00 |
| 4 | STRC 04 | 1.97 | 0.00 | 8822.07 | 0.68 | 0.00 | 0.40 | 8822.01 | 0.62 | 0 11:56 | 0 00:00 | 0.00 | 0.00 |
| 5 | STRC 05 | 1.97 | 0.00 | 8821.76 | 0.66 | 0.00 | 0.41 | 8821.70 | 0.60 | 0 11:56 | 0 00:00 | 0.00 | 0.00 |
| 6 | STRC 06 | 1.97 | 0.00 | 8820.93 | 0.55 | 0.00 | 0.53 | 8820.88 | 0.50 | 0 11:57 | 0 00:00 | 0.00 | 0.00 |
| 7 | STRC 07 | 1.97 | 0.00 | 8819.75 | 0.44 | 0.00 | 0.63 | 8819.72 | 0.41 | 0 11:57 | 0 00:00 | 0.00 | 0.00 |
| 8 | STRC 08 | 1.97 | 0.00 | 8819.09 | 0.39 | 0.00 | 0.69 | 8819.06 | 0.36 | 0 11:57 | 0 00:00 | 0.00 | 0.00 |
| 9 | STRC 09 | 1.97 | 0.00 | 8817.70 | 0.39 | 0.00 | 1.29 | 8817.67 | 0.36 | 0 11:57 | 0 00:00 | 0.00 | 0.00 |

## Pipe Input

| SN | Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Pipe Shape | Pipe Diameter or Height (in) | Pipe Width (in) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate | No. of Barrels |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PIPE 01 | 34.42 | 8823.19 | 3.50 | 8823.11 | 0.00 | 0.08 | 0.2200 | CIRCULAR | 12.000 | 12.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 2 |
| 2 | PIPE 02 | 54.49 | 8823.11 | 0.00 | 8822.73 | 0.00 | 0.39 | 0.7100 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 3 | PIPE 03 | 67.80 | 8822.73 | 0.00 | 8822.35 | 0.00 | 0.37 | 0.5500 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 4 | PIPE 04 | 153.01 | 8822.35 | 0.00 | 8821.39 | 0.00 | 0.96 | 0.6300 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 5 | PIPE 05 | 44.68 | 8821.39 | 0.00 | 8821.10 | 0.00 | 0.29 | 0.6600 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 6 | PIPE 06 | 58.03 | 8821.10 | 0.00 | 8820.38 | 0.00 | 0.71 | 1.2300 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 7 | PIPE 07 | 45.51 | 8820.38 | 0.00 | 8819.31 | 0.00 | 1.08 | 2.3700 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 8 | PIPE 08 | 14.85 | 8819.31 | 0.00 | 8818.70 | 0.00 | 0.61 | 4.1000 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 9 | PIPE 09 | 35.56 | 8818.70 | 0.00 | 8817.31 | 0.00 | 1.39 | 3.9000 | CIRCULAR | 12.000 | 12.000 | 0.0150 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |
| 10 | PIPE 10 | 27.01 | 8817.31 | 0.00 | 8812.03 | 0.00 | 5.28 | 19.5500 | CIRCULAR | 15.000 | 15.000 | 0.0120 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No | 1 |

## Pipe Results

| SN | Element ID | Peak Flow (cfs) | Time of Peak Flow Occurrence (days hh:mm) | Design Flow Capacity (cfs) | Peak Flow/ Design Flow Ratio | Peak Flow Velocity (ft/sec) | Travel Time (min) | Peak Flow Depth (ft) | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged (min) | Froude Number | Reported Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PIPE 01 | 1.97 | 0 11:55 | 3.64 | 0.54 | 2.36 | 0.24 | 0.52 | 0.52 | 0.00 | | Calculated |
| 2 | PIPE 02 | 1.97 | 0 11:55 | 2.60 | 0.76 | 3.64 | 0.25 | 0.65 | 0.65 | 0.00 | | Calculated |
| 3 | PIPE 03 | 1.97 | 0 11:55 | 2.30 | 0.86 | 3.29 | 0.34 | 0.71 | 0.71 | 0.00 | | Calculated |
| 4 | PIPE 04 | 1.97 | 0 11:56 | 2.45 | 0.80 | 3.48 | 0.73 | 0.68 | 0.68 | 0.00 | | Calculated |
| 5 | PIPE 05 | 1.97 | 0 11:56 | 2.51 | 0.78 | 3.53 | 0.21 | 0.67 | 0.67 | 0.00 | | Calculated |
| 6 | PIPE 06 | 1.97 | 0 11:57 | 3.42 | 0.57 | 4.51 | 0.21 | 0.54 | 0.54 | 0.00 | | Calculated |
| 7 | PIPE 07 | 1.97 | 0 11:57 | 4.75 | 0.41 | 5.76 | 0.13 | 0.45 | 0.45 | 0.00 | | Calculated |
| 8 | PIPE 08 | 1.97 | 0 11:57 | 6.25 | 0.31 | 7.04 | 0.04 | 0.39 | 0.39 | 0.00 | | Calculated |
| 9 | PIPE 09 | 1.97 | 0 11:57 | 6.10 | 0.32 | 6.92 | 0.09 | 0.39 | 0.39 | 0.00 | | Calculated |
| 10 | PIPE 10 | 1.97 | 0 11:57 | 30.94 | 0.06 | 14.06 | 0.03 | 0.21 | 0.17 | 0.00 | | Calculated |

# Storage Nodes

## Storage Node : POND_18

### Input Data

| | |
|---|---|
| Invert Elevation (ft) | 8819.69 |
| Max (Rim) Elevation (ft) | 8826.00 |
| Max (Rim) Offset (ft) | 6.31 |
| Initial Water Elevation (ft) | 8823.69 |
| Initial Water Depth (ft) | 4.00 |
| Ponded Area (ft²) | 0.00 |
| Evaporation Loss | 0.00 |

### Output Summary Results

| | |
|---|---|
| Peak Inflow (cfs) | 17.58 |
| Peak Lateral Inflow (cfs) | 17.58 |
| Peak Outflow (cfs) | 1.97 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 8824.37 |
| Max HGL Depth Attained (ft) | 4.68 |
| Average HGL Elevation Attained (ft) | 8824.22 |
| Average HGL Depth Attained (ft) | 4.53 |
| Time of Max HGL Occurrence (days hh:mm) | 1 00:06 |
| Total Exfiltration Volume (1000-ft³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

# Solids Settling Detention Time Calculations

**Ponds 11 and 12 Solids removal via dredge required detention time (no flocculent)** ACJ

Ferguson, R. I., and M. Church (2004), A Simple Universal Equation for Grain Settling Velocity, Journal of Sedimentary Research, 74(6) 933-937, doi: 10.1306/051204740933

| | | |
|---|---|---|
| Target Particle Size | 0.0030 | mm |
| | 0.000003 | Meters |
| Pumping Rate | 900 | gpm |
| | 2.008929 | cfs |
| Op time | 8 | hr/day |
| | 57857.14 | cf/day w/ shutdown overnight |
| Pond 13 Size | 100 | ft width |
| | 390 | ft length |
| | 2 | ft depth |
| | 78000 | cf |
| | 0.9 | ac |
| Residence time | 1.3 | day |
| | 32 | hours |
| Settling Velocity | 8.08E-06 | m/s |
| | 2.65E-05 | ft/s |
| Settling time | 75494 | sec |
| | 21 | hours |
| | 11 | Residence - Settling time (hrs) (must be zero or positive) |

**Assumptions**

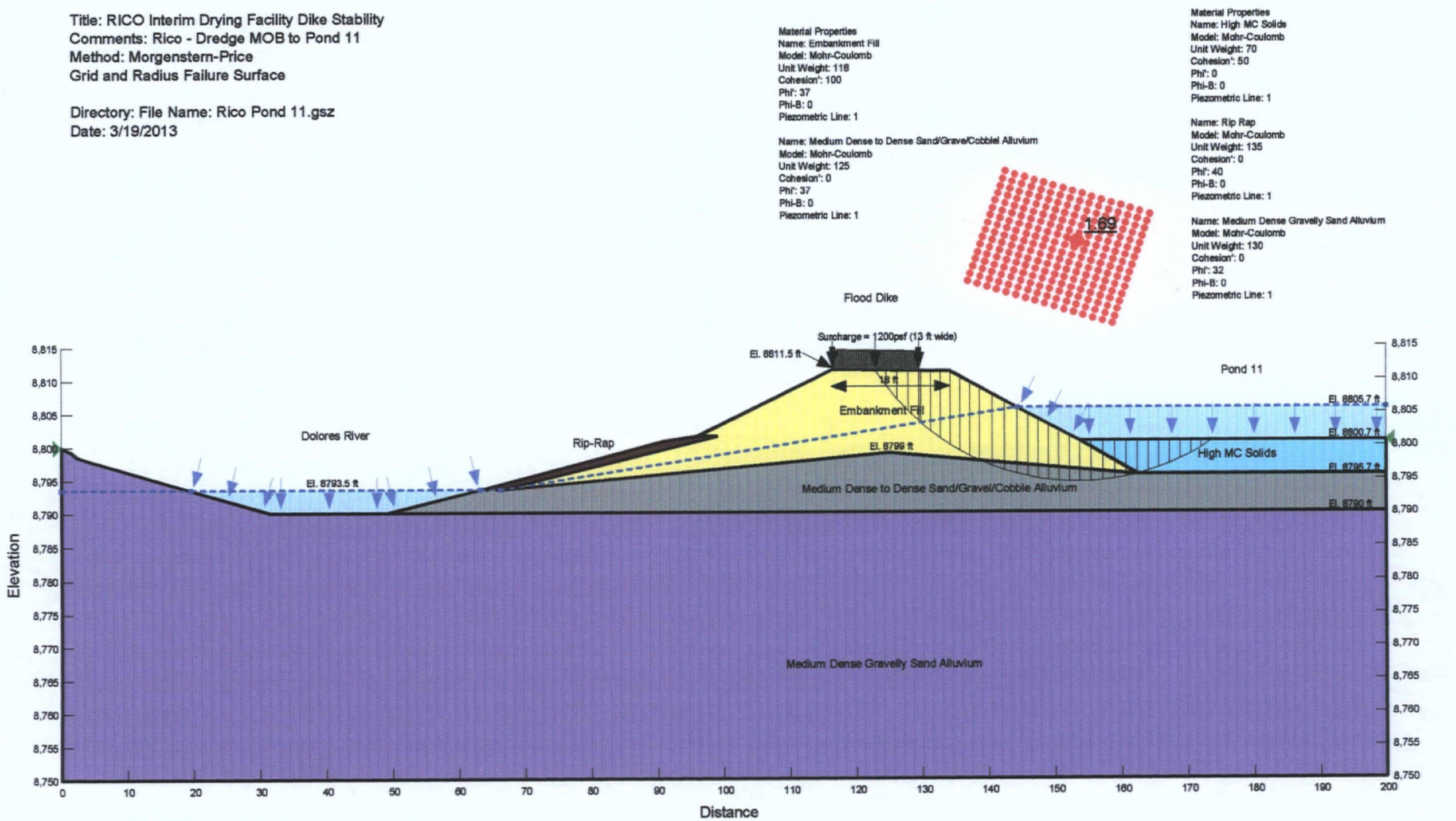
Uniformly distributed flow in detention pond

0.006 mm = 70% removal (based on Pond 15 solids gradation)

0.003 mm = 80% removal

Conservatively does not account for increased settling due to pond seepage, which increases residence time

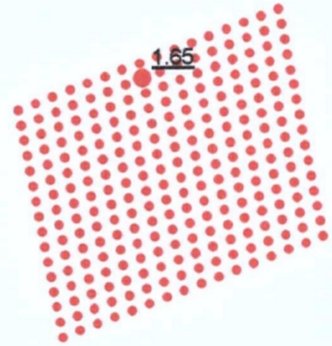
# SLOPE/W Stability Analysis Results



Title: RICO Interim Drying Facility Dike Stability
Comments: Rico - Dredge MOB to Pond 11
Method: Morgenstern-Price
Grid and Radius Failure Surface
Directory: File Name: Rico Pond 11.gsz
Date: 3/19/2013
Material Properties
Name: Embankment Fill
Model: Mohr-Coulomb
Unit Weight: 118
Cohesion': 100
Phi': 37
Phi-B: 0
Piezometric Line: 1
Name: Medium Dense to Dense Sand/Grave/Cobblel Alluvium
Model: Mohr-Coulomb
Unit Weight: 125
Cohesion': 0
Phi': 37
Phi-B: 0
Piezometric Line: 1
Material Properties
Name: High MC Solids
Model: Mohr-Coulomb
Unit Weight: 70
Cohesion': 50
Phi': 0
Phi-B: 0
Piezometric Line: 1
Name: Rip Rap
Model: Mohr-Coulomb
Unit Weight: 135
Cohesion': 0
Phi': 40
Phi-B: 0
Piezometric Line: 1
Name: Medium Dense Gravelly Sand Alluvium
Model: Mohr-Coulomb
Unit Weight: 130
Cohesion': 0
Phi': 32
Phi-B: 0
Piezometric Line: 1
1.69
Flood Dike
Surcharge = 1200psf (13 ft wide)
El. 8811.5 ft
18 ft
Pond 11
El. 8805.7 ft
El. 8800.7 ft
El. 8795.7 ft
El. 8790 ft
Embankment Fill
El. 8799 ft
High MC Solids
Dolores River
Rip-Rap
El. 8793.5 ft
Medium Dense to Dense Sand/Gravel/Cobble Alluvium
Medium Dense Gravelly Sand Alluvium
Elevation
8,815
8,810
8,805
8,800
8,795
8,790
8,785
8,780
8,775
8,770
8,765
8,760
8,755
8,750
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance

Title: RICO Interim Drying Facility Dike Stability
Comments: Rico - Dredge MOB to Pond 11
Method: Morgenstern-Price
Grid and Radius Failure Surface

Directory: File Name: Rico Pond 11.gsz
Date: 3/19/2013



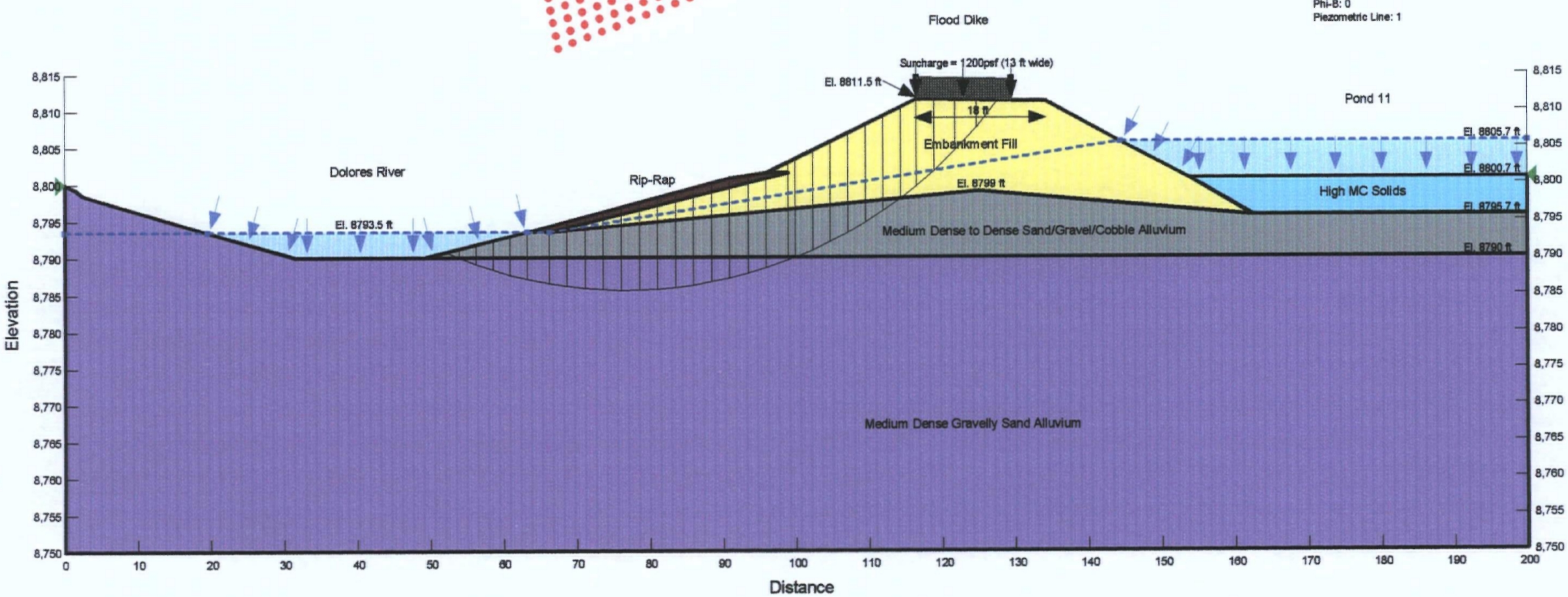

Material Properties
Name: Embankment Fill
Model: Mohr-Coulomb
Unit Weight: 118
Cohesion': 100
Phi': 37
Phi-B: 0
Piezometric Line: 1

Name: Medium Dense to Dense Sand/Grave/Cobble/ Alluvium
Model: Mohr-Coulomb
Unit Weight: 125
Cohesion': 0
Phi': 37
Phi-B: 0
Piezometric Line: 1

Material Properties
Name: High MC Solids
Model: Mohr-Coulomb
Unit Weight: 70
Cohesion': 50
Phi': 0
Phi-B: 0
Piezometric Line: 1

Name: Rip Rap
Model: Mohr-Coulomb
Unit Weight: 135
Cohesion': 0
Phi': 40
Phi-B: 0
Piezometric Line: 1

Name: Medium Dense Gravelly Sand Alluvium
Model: Mohr-Coulomb
Unit Weight: 130
Cohesion': 0
Phi': 32
Phi-B: 0
Piezometric Line: 1



Title: RICO Interim Drying Facility Dike Stability
Comments: Rico - Dredge MOB to Pond 12
Method: Morgenstern-Price
Grid and Radius Failure Surface

Directory: File Name: Rico Pond 12.gsz
Date: 3/19/2013

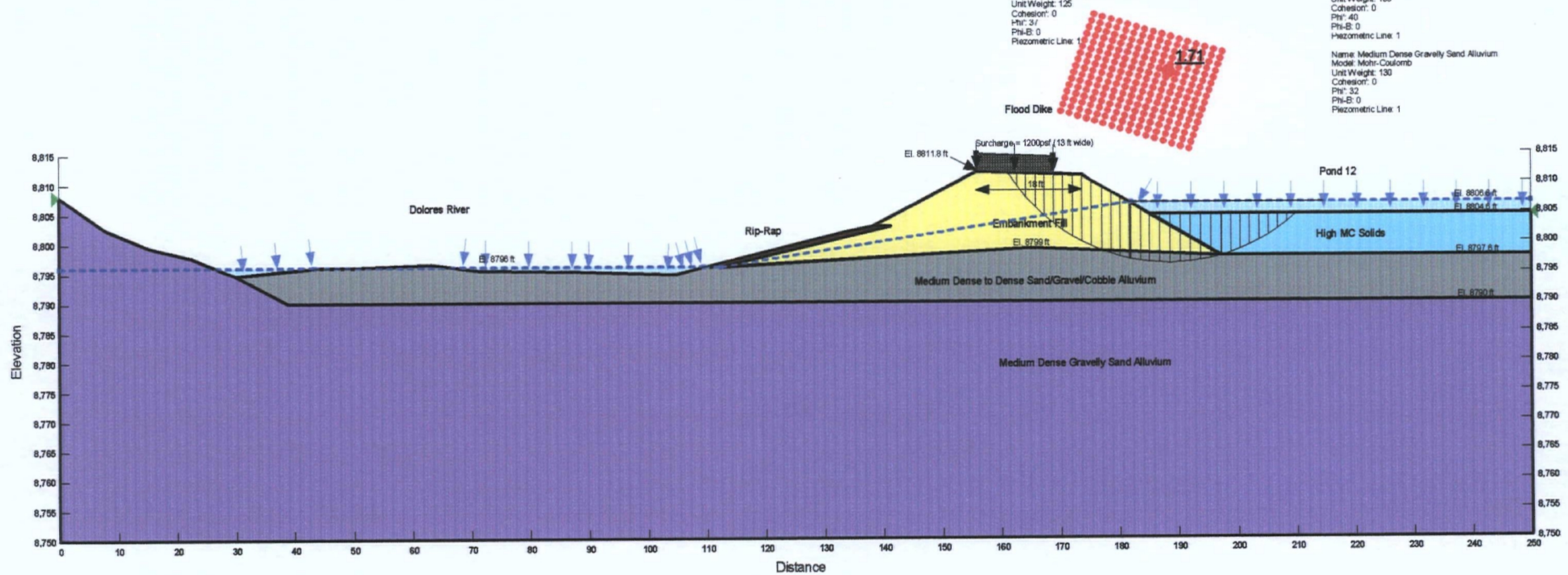
Material Properties
Name: Embankment Fill
Model: Mohr-Coulomb
Unit Weight: 118
Cohesion': 100
Phi': 37
Phi-B: 0
Piezometric Line: 1

Name: Medium Dense to Dense Sand/Grave/Cobblel Alluvium
Model: Mohr-Coulomb
Unit Weight: 125
Cohesion': 0
Phi': 37
Phi-B: 0
Piezometric Line: 1

Material Properties
Name: High MC Solids
Model: Mohr-Coulomb
Unit Weight: 70
Cohesion': 50
Phi': 0
Phi-B: 0
Piezometric Line: 1

Name: Rip Rap
Model: Mohr-Coulomb
Unit Weight: 135
Cohesion': 0
Phi': 40
Phi-B: 0
Piezometric Line: 1

Name: Medium Dense Gravelly Sand Alluvium
Model: Mohr-Coulomb
Unit Weight: 130
Cohesion': 0
Phi': 32
Phi-B: 0
Piezometric Line: 1



Title: RICO Interim Drying Facility Dike Stability
Comments: Rico - Dredge MOB to Pond 12
Method: Morgenstern-Price
Grid and Radius Failure Surface

Directory: File Name: Rico Pond 12.gsz
Date: 3/19/2013